

THE INITIATION OF THE AXILLARY BUD IN *CALANTHE*

TSAN-PIAO LINN⁽¹⁾ and SU-HWA TSAI CHIANG⁽²⁾

Abstract: The origin of the axillary bud primordium in nine species of *Calanthe* (Orchidaceae) is cauline rather than of leaf origin, though the early stages of the bud is closely related with its associated leaf primordium above it. The first indication of the axillary bud is recognized by a periclinal division occurring in the third layer from the protoderm at the base of the second plastochron or from behind the second plastochron. The shell zone is obvious in the axillary bud at early stages of development.

INTRODUCTION

Studies on the histogenesis of the axillary bud have been made on the shoot apex anatomy of many plants. It has been documented in many different groups of plants by Zimmermann (1928), Evans and Grover (1940), Sharman (1945), Wardlaw (1943a, 1943b, 1946), Majumdar and Datta (1946) and Garrison (1949). Indeed, in addition to leaf histogenesis, the initiation pattern of the axillary bud in the shoot apex has been a most attractive topic for botanists. Some of the workers interpreted the bud primordium as being derived from a portion of the apical meristem (Wardlaw, 1943a, 1943b, 1946; Sterling, 1945, 1947 and Miller and Wetmore, 1946) but others considered that it originated from previously vacuolated tissue. (Majumdar, 1942; Sharman, 1942; and Majumdar and Datta, 1946) The existence of a shell zone in some dicotyledons has been recognized and its possible function was conjectured by Shah and Patel (1972). The vacuolarization of the axillary bud has also been described in several papers (Miller and Wetmore, 1946; Garrison, 1949). Evans and Grover (1940) and Sharman (1945) stated that the localization and the first indication of the axillary bud initial in the Gramineae did not have any developmental relationship with the subtending leaf. An additional study on the histogenesis of the axillary bud of the Orchidaceae is being made in the present report. The constitution as well as the changes of the cell arrangement in the early stages of the axillary bud primordium are herewith described.

MATERIALS AND METHODS

The following nine species of *Calanthe*: *C. arisanensis*, *C. caudatilabella*, *C. forsythiiiflora*, *C. furcata*, *C. kazuoii*, *C. longicalcarata*, *C. nigropuncticulata*, *C. reflexa* and *C. venusta*, all native to Taiwan were used in this investigation. All the shoot apices were collected in 1970-1972. With the one exception of *C. venusta* all the species examined bear pseudobulbs. Buds initiated in October, were collected and fixed with formalin acetic-alcohol (FAA). Materials were then dehydrated in a tertiary butanol series and embedded in tissuesmat, stained with safranin, tannic acid and orange G (Sharman, 1943).

(1) 林讚標 Assistant in Silviculture Division Taiwan Forestry Research Institute.

(2) 江蘇波華 Professor of Botany, National Taiwan University.

OBSERVATIONS

Axillary buds in all the species examined in the present investigation were initiated at the region right above the leaf base subtending them and always were in the second plastochrons (Figs. 1, 10a) or latter plastochrons (Figs. 5, 7, 8). The first sight of a leaf initial is recognized by the occurrence of a periclinal division in the second tunica layer. It always takes place earlier than the initiation of the associated axillary bud below it (Fig. 1). The various planes of cell divisions in the leaf initial are followed by the first periclinal division, eventually forming a buttress. During the development of the leaf the outer tunica cells only divide anticlinally. The leaf buttress is made up of cells mainly formed from the derivatives of the first and second tunica, rarely from other layers. So that most of the mesophyllous cells in the leaf are derived from the second tunica.

The first indication of the bud primordium is characterized by a periclinal division occurring in the third layer from the protoderm (Figs. 2, 5, 6), these are followed by anticlinal divisions in both the first and second layers which consequently give rise to the tunica of the apical meristem of the future bud. The regular pattern of the anticlinal divisions in the second layer probably disappears as the bud grows. Since the stratification of the second tunica in a bud of later growth is obscure (Fig. 3).

The initiation of the axillary bud in the present materials was characterized by following the formation of the shell zone on the adaxial side of the bud. The shell zone is formed from the parenchymatized derivatives of ground tissue of the stem, which mainly divide anticlinally, forming the cambiform cells. The cells in the shell zone are somewhat elongated being parallel to the subtending arc of the bud base as seen in its longitudinal section. Differentiation of the shell zone progresses from the epidermis to the inner layers of the ground tissue on the adaxial side of the bud meristem. The shell zone always loses its regularity gradually toward the base of bud (Figs. 5, 6, 9). The shell zone is made up of one to a few layers of cells. The compact pattern of the cell arrangement in shell zone disappears gradually during bud development. In some species the shell zone is not distinct during bud development (Fig. 7).

The first periclinal division of the leaf initial occurs in the peripheral zone of the shoot apical meristem beneath the superficial layer. The first periclinal wall of the bud initial forms on the abaxial side of the newly formed leaf primordium. However there is some distance between the two primordia. The boundary between the newly initiated axillary bud and its associated leaf is obscure during the early stages. It shows a continual pattern in cell zonation and does not separate prior to the development of shell zone. The shell zone first appears at the base of the plastochron. The first cell in the shell zone becomes elongated by the formation of a new oblique cell wall or the axial elongation of the main shoot (Figs. 1, 6). Apparently the axillary bud initiates at the base of the second plastochron or other plastochrons rather than at the base of its associated leaf. In other words, it initiates on the abaxial side of its associated leaf primordium. Then the leaf primordium and its associated axillary bud gradually separate from each other by the formation of the shell zone and later by the elongation of the main shoot (Fig. 10). Consequently the axillary bud is transferred to the adaxial side of its subtending leaf which is located below it (Fig. 10d).

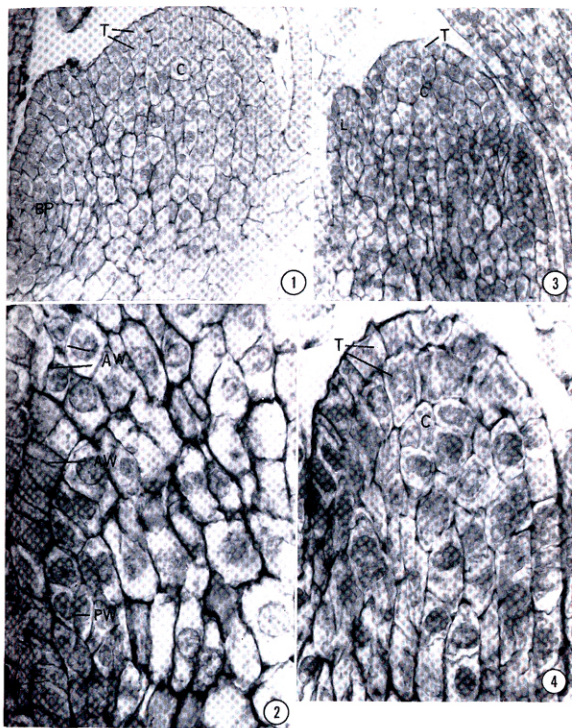


Fig. 1. Longitudinal section of the apical meristem of *C. Kazuoi*, $\times 290$.

Fig. 2. Enlarged view of the bud primordium and leaf from Fig. 1, $\times 785$.

Fig. 3. Median longitudinal section of axillary bud of *C. arisanensis*, $\times 280$.

Fig. 4. Median longitudinal section showing the axillary bud of *C. longicalcarata*, $\times 785$.

B: bud; BP: bud primordium; AD: anticlinal division; C: corpus; L: leaf; AW: anticlinal wall; LP: leaf primordium; T: tunica; FT: future tunica; PD: periclinal division; SZ: shell zone; PW: periclinal wall.

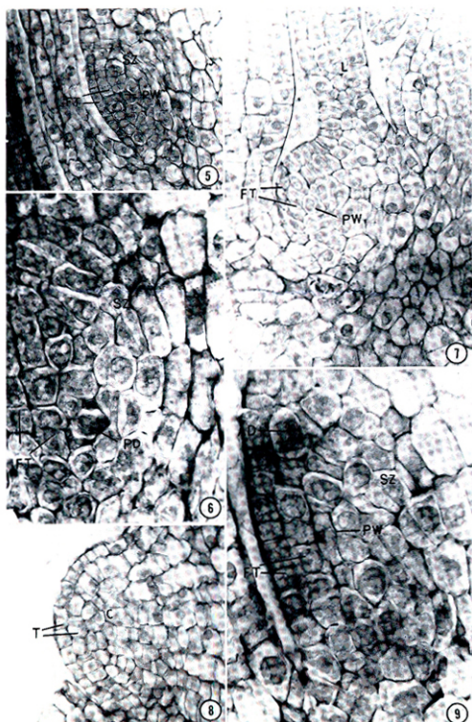


Fig. 5. Longitudinal section of *C. kazuoi* showing the axillary bud at the abaxial side of the associated leaf base, $\times 240$.

Fig. 6. Longitudinal section of *C. venusta*, $\times 672$.

Fig. 7. Longitudinal section of *C. caudatilabella*, $\times 240$.

Fig. 8. Longitudinal section of *C. furcata*, $\times 240$.

Fig. 9. Longitudinal section of *C. reflexa*, $\times 672$.

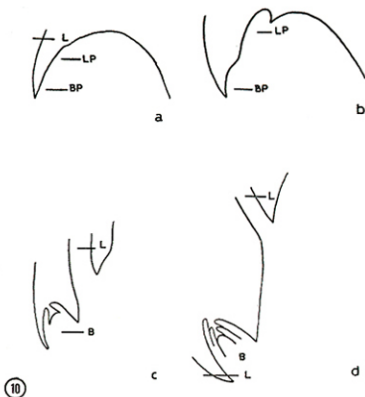


Fig. 10. Diagrams showing the relationship among leaf, bud and main shoot, note the axillary bud always occurs on the adaxial side of subtending leaf base.

DISCUSSION

The axillary bud primordium observed in the present investigation originates at the base of the second plastochron or other plastochrons. Apparently it is not derived from the apical meristem of the main shoot. The manner of bud initiation in the present material agrees with that described for *Thujaopsis colabrata* (Seelinger, 1954) and *Solanum tuberosum* (Sussex, 1955). But in some other plants buds were observed originating from the first plastochron. They were closely related to the apical meristem of the main shoot (Cutter, 1967).

In the present investigation, the axillary bud was formed at a region somewhat farther away from the shoot apical meristem. It was in the area where the cells were being differentiated. The bud primordium can be termed a detached meristem (Wardlaw, 1943). We found the bud initiates on the abaxial side of its associated leaf primordium. It is cauline rather than of leaf origin, though the localization of the bud in later stages shows a close connection with the young leaf which develops below it. The pattern of the early stages of development have received more attention than the later stages have received in the study of ontogeny.

The pattern of the shell zone formation of *Calanthe* is similar to other monocotyledons in the localization of its bud initial as described by Sharman (1945) and is very similar to that described for some dicotyledons. Shah and Petal (1972) described six patterns of shell zone initiation which were present in the materials

they observed. The shell zone in the young bud of *Calanthe* is coordinated with the first pattern described by them, but it differs in that it arises from derivatives of the ground meristem of the stem on the adaxial side of bud meristem.

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